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Cortinarius mikedavisii sp. nov. from northern California

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Abstract — A new *Cortinarius* (subg. *Phlegmacium*) species is described from northern California. *Cortinarius mikedavisii* is a brightly colored bulbopodium in sect. *Laeticolores*. Phylogenetically it belongs in the /cupreorufus clade.

Key Words — *Cortinariaceae*, fungal taxonomy, nrITS data

Introduction

Cortinarius sect. *Laeticolores* M.M. Moser ex Moënne-Locc. & Reumaux was erected to accommodate some of the brightly colored bulbopodiums of subg. *Phlegmacium*. The section type was originally designated as "*Cortinarius orichalceus*" (a misapplied name, not conspecific with *Agaricus orichalceus* Batsch); its valid name is *Cortinarius cupreorufus* Brandrud (Brandrud et al. 1994).

Recent molecular studies (Frøslev et al. 2007, Garnica et al. 2009), congruent with my own phylogenetic analyses, show that the broad circumscription of sect. *Laeticolores* by Moser (1960) and Bidaud et al. (2004) is polyphyletic. However, a group of species around *C. cupreorufus* forms a well-supported clade including *C. rufo-olivaceus* (Pers.) Fr. and *C. prasinus* (Schaeff.) Fr. The /cupreorufus clade, which represents the core of sect. *Laeticolores,* is well represented in western North America with *Cortinarius mikedavisii,* described here as new, and other undescribed species (Fig 1).

Materials & methods

Methods for morphological studies and DNA extraction, PCR conditions and primers, PCR product clean up, and sequencing were employed as outlined in Bojantchev & Davis (2011). Color codes follow Munsell™ soil color charts (Anonymous 2000). Collections are stored in the private herbarium of the first author or at the University of California herbarium in Berkeley (UC) where noted.

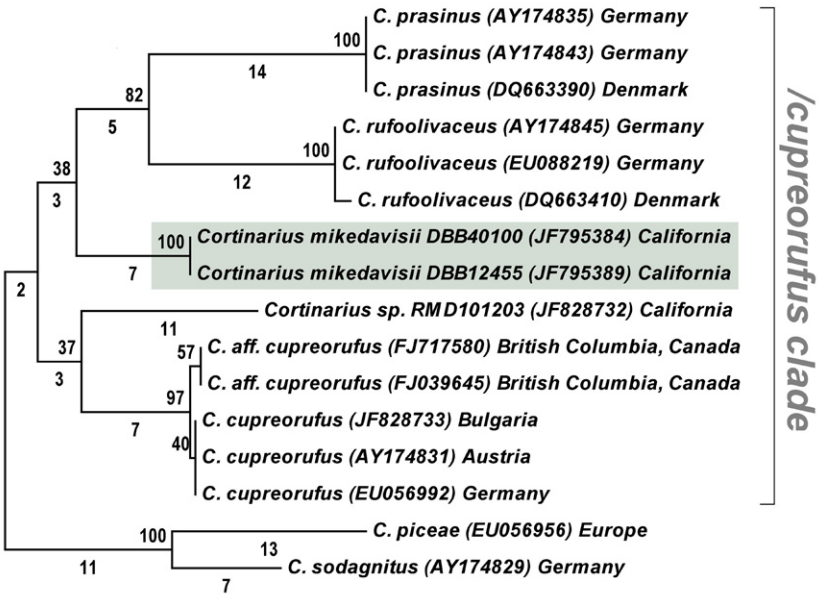

Fig 1. Phylogenetic tree inferred by maximum parsimony analysis of 16 *Cortinarius* subg. *Phlegmacium* nrITS sequences. The tree shows the position of *C. mikedavisii* relative to its closest neighbors in the /cupreorufus clade. The percentages of clustered replicate trees based on the bootstrap test (1000 replicates) are shown above the branches while the branch lengths representing estimated nucleotide substitutions are shown below. GenBank accession numbers are enclosed in brackets.

Phylogenetic analysis—During these studies all *Cortinarius* nrDNA sequences from the public databases GenBank (http://www.ncbi.nlm.nih.gov) and UNITE (http://unite.ut.ee/) were downloaded and reviewed. Preliminary phylogenetic analysis (not shown) of 1012 *Phlegmacium* nrITS sequences from the northern hemisphere, including 312 sequences from the author's own collections, clarified the closest relatives of *C. mikedavisii* and resolved its position within the /cupreorufus clade of the calochroid super-clade as defined by Frøslev et al. (2007) and Garnica et al. (2009).

A set of sixteen *Phlegmacium* sequences representing eight taxa was selected for a detailed phylogenetic analysis. Twelve sequences were sourced from GenBank and four sequences are from the author's collections. Fourteen sequences were from the /cupreorufus clade, represented by three well known European taxa combined with *C. mikedavisii* and two western North American taxa close to *C. cupreorufus*. *Cortinarius sodagnitus* Rob. Henry and *C. piceae* Frøslev et al. {formerly known as *C. calochrous* var. *coniferarum* (M.M. Moser) Nezdojm.} were selected as the outgroup because they represent the core of the calochroid cortinarii but are distant from the /cupreorufus clade.

Sequence alignments were generated with MAFFT v6.821b (Katoh et al. 2002) with the G–INS–i global alignment iterative refinement strategy. Minimal gap opening and extension penalties were set for better resolution of the more variables sectors within the nrITS. The alignments were visually inspected and corrected where needed.

The evolutionary history was inferred using the Maximum Parsimony method as implemented by MEGA5 (Tamura et al. 2007). The MP trees were generated by the Close-Neighbor-Interchange algorithm with search level 0 in which the initial trees were obtained with the random addition of sequences (10 replicates). The percentage of replicate trees in which the associated taxa clustered together was calculated from a bootstrap test with 1000 replicates. The search resulted in thirty most parsimonious trees (length = 97), which differed mainly in the topology of the terminal nodes. One tree is given in Fig. 1.

Taxonomy

Fig 2. *Cortinarius mikedavisii* (UC 1860820, holotype).

Cortinarius mikedavisii Bojantchev, **sp. nov.** Figs 2–6

MycoBank MB 561221

Pileo 60–220 mm lato, hemispherico, dein planoconvexo, planoconcavo, glutinoso, roseobrunneo, cum KOH purpureobrunneo, margine involuto. Lamellis emarginatis, caesiis dein flavidis, purpureobrunneis, in statu senili. Stipite 50–140 mm longo, cylindrico, bulbo marginato, 30–50 mm lato. Velo universale roseobrunneo. Velo partiale copioso, flavido. Carne caesio dein albido. Sapore miti. Sporis 10–13 × 6–7 µm, amygdaliformibus, verrucosis, basidiis 28–42 × 8–9 µm, tetrasporigeris, fibulis praesentibus.

Type: USA. California: Mendocino County, Caspar, Caspar Cemetery, under *Picea sitchensis*, 27 Nov 2010, Bojantchev DBB40100 (**Holotype** UC 1860820; Genbank nrITS JF795384).

Etymology: In honor of Prof. Mike Davis whose encouragement and support in the area of molecular genetics made these *Cortinarius* studies possible.

Stature pileocarpous bulbopodium. Pileus 60–220 mm diam., hemispherical to convex when young, plano-convex to plano-concave at age; margin involute then straight; colors intense, mostly reddish to orange brown on the disk, varying from carmine brown to rose brown (10R 3/6–4/8), paler on the margin, copper brown to sulphur yellow (10R 6/8–7.5YR 7/8); surface very glutinous when wet, glabrous to dull glossy when dry. Lamellae crowded, 10–22 mm broad, blue (GLEY2 6/10G–8/10G) at first, turning olive (5Y 6/4–8/4) then yellowish clay (5Y 8/6–8/8) with purplish tinges, then purplish brown as the spores mature; edge even; attachment sinuate; lamellulae abundant. Stipe 50–140 mm long, 15–30 mm wide, cylindrical to subclavate above the bulb, pale yellow, with rose brown streaks from universal veil. Bulb 30–80 mm diam at the widest point, well-developed, abruptly emarginate, tapering below, rose to purplish brown around margin; the subterrestrial part with a pale to sulphur yellow cottony mycelial felt and rhizomorphs. Universal Veil rose to purplish brown, leaving copious remnants on the pileus and bulb margin. Cortina yellow, leaving an annular zone of dense fibrils on the stipe. Context white to bluish at first, paling to white at maturity with yellow tinges in the bulb. Odor earthy. Taste mild, earthy. Macrochemical Reactions 5% KOH strong and complex, dark purple red on the pileus; on the context pale olive at first, soon lilac on pileus context, strongly purplish on bulb context and paler on stipe context. Spore Deposit deep rusty brown.

Basidiospores (9.5–)10.5–13.2(–15.5) × (5.7–)6.2–7.2(–7.8) µm (mean 11.5 × 6.7 µm), Q = 1.61–1.78, Q_{av} = 1.72 (N = 178, 7 basidiomata, four collections), amygdaliform, some with apical papilla, strongly verrucose. Basidia 28–42 × 8–9 µm, 4-spored, cylindro-clavate, clamped. Gill edge sparsely fertile.

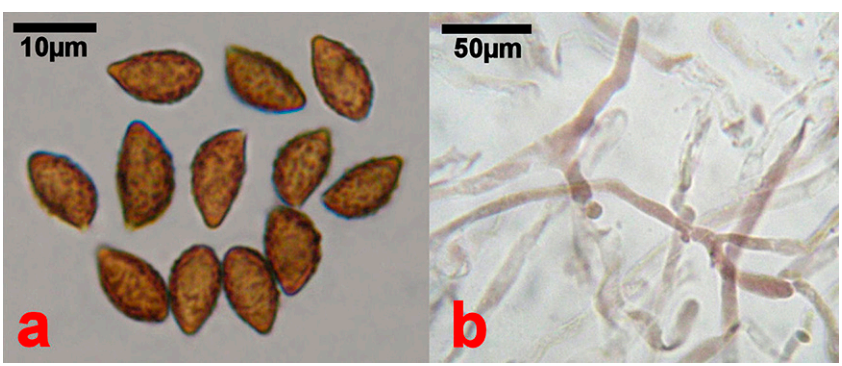

Fig 3. *Cortinarius mikedavisii*. a) Basidiospores (UC 1860820, holotype) b) Cuticle hyphae with an olive to purplish intracellular pigment in 5% KOH (UC 1860820, holotype)

Fig 4. *Cortinarius mikedavisii.* 5% KOH reaction a) UC 1860820, holotype b) DBB12455

Cystidia not observed. Pileipellis an ixocutis, simplex, no hypodermium detected, composed of parallel to interwoven hyphae in a dense gelatinous matrix 230–300 µm thick, made up of 4–12 µm wide, irregular hyphae, with greenish to purplish intracellular pigment when mounted in 5% KOH. No distinct reactions to Melzer's reagent were observed. Clamp connections common in all parts.

Habitat and distribution — *Cortinarius mikedavisii* appears to be an uncommon species. Currently it is known from only three locations, at two of which it fruits regularly. The habitat is mixed woods with Sitka spruce (*Picea sitchensis* (Bong.) Carrière) being the one common symbiont in all locations. The author has never seen it south of Mendocino. Its distribution appears to be limited to northern California and southern Oregon, where it was collected once. There are no matching records from Washington and British Columbia despite the intensive collecting and molecular cataloguing that has taken place in these regions.

Additional collections examined: **USA. California**: Mendocino County, Caspar, Caspar Cemetery, under *Picea sitchensis,* 23 Dec 2008, Bojantchev DBB12455, (UC 1860821, Genbank nrITS JF795389); Jackson State Demonstration Forest, under *Picea sitchensis,* 22 Nov 2009, Bojantchev DBB28043; **Oregon**: Curry County, Samuel Boardman State Park, under *Picea sitchensis,* 11 Nov 2009, Bojantchev DBB27700.

Discussion

Cortinarius mikedavisii is a beautiful species that so stands out with its large size and bright colors that it should present no difficulty for field identification. The distinctive alkaline color reaction indicates the presence of rufoolivacin, an anthraquinone compound, which Steglich & Oertel (1985) detected in other members of the /cupreorufus clade.

Phylogenetically, *C. mikedavisii* (Fig 1) stands almost equidistant in the clade between the two main branches of *C. cupreorufus* and *C. rufo-olivaceus*. *Cortinarius rufo-olivaceus,* a beech associate from Europe, is not known from

Fig 5. *Cortinarius mikedavisii.* a) Mature basidiomata can become very large (DBB12455). The scale is a US quarter dollar coin (~25mm) b) Basidiomata in a button stage (DBB28043)

Fig 6. *Cortinarius mikedavisii* — a study in the development of a pileocarpous bulbopodium. Note the changing color of the gills. a) DBB28043 b) DBB28043 c) DBB27700

Fig 7. *Cortinarius mikedavisii.* a) DBB12455. The scale is a US quarter dollar coin (~25mm) b) Yellow mycelial strands (DBB27700)

western North America. *Cortinarius cupreorufus* (Fig 8a) and its western American ally differ in the straw yellow lamellae and generally more pale olive pileus, colors noticeable in all stages of development. The alkaline reactions in *C. mikedavisii* are more intense than seen in *C. cupreorufus,* and the context turns lilac to purplish red immediately, bypassing the pale olive stage. There is

Fig 8. Related species: a) *Cortinarius cupreorufus* DBB19840 from Europe; b) *Cortinarius* sp. RMD101203, an undescribed species from the xeric oak stands of central and southern California.

an undescribed species in the same clade, represented by coll. "RMD101203" in Fig. 1, which is only found in xeric oak stands of the central valley and southern California and differs significantly in colors (Fig. 8b). All members of the /cupreorufus clade share large (10–13 µm) amygdaloid spores with very rough ornamentation.

Complete iconography of *C. mikedavisii* and a comparative image study is available on http://www.mushroomhobby.com.

Acknowledgements

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